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An examination of the potential reductions in strategic nuclear weapons and the effects on first strike and geopolitical stability. Deep cuts in nuclear weapons to levels of 2500, 1500, and 800 warheads are considered.

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REDUCED STRATEGIC FORCES
AND RUSSIAN-AMERICAN
STABILITY ISSUES

F. S. NYLAND

APRIL, 1997

R-124-NE

PREFACE

This report provides an examination of three possible sets
of force structures that might set terms for future strategic
arms reduction treaties between the U.S. and Russia. The
measures used in this examination include first strike stability
with and without various levels of national ballistic missile
defenses for both the U.S. and Russia, and one indicator of
geopolitical stability. Various force structures and postures
provide illustrative results of a general method of analyzing the
impact of the reductions in strategic nuclear arsenals.

This report should be of interest to members of the arms
control community, the defense community, and others interested
in the future prospects for reductions in the strategic nuclear
forces of the U.S. and Russia.

None of the material contained in this report represents the
official views of the U.S. Arms Control and Disarmament Agency,
the U.S. Department of Defense, or any other U.S. Government
agency or organization. The author is solely responsible for the
contents of this report. Comments are welcome and should be
directed to the author.

CONTENTS

INTRODUCTION

Although the U.S. Senate has ratified the START II Treaty, arguments have arisen within the Russian government about the fairness of its terms, the expense of meeting its terms, and concerns about the number of new missiles that would need to be procured to meet its terms. It would appear that the Russian government does not want to procure new ballistic missiles, only to have to destroy them under the terms of a follow-on START III Treaty [1]. The Defense Committee of the Duma has suggested that implementation of the START II Treaty be delayed. Further, Moscow is pressing for a framework of START III as a condition of START II ratification.

In March, 1997, Presidents Clinton and Yeltsin agreed that once START II entered into force, the United States and Russia will immediately begin negotiations on a START III agreement, which would include lower aggregrate levels of strategic nuclear weapons of 2,000-2,500 warheads for each of the parties [2]. In this agreement, both Presidents concurred that full compliance with START III would be accomplished by December 31, 2007.

The purpose of this report is to examine several aspects of strategic force reductions as a preliminary and tentative step in considering suggested frameworks for further reductions in nuclear warheads by the United States and Russia. None of the suggested guidelines presented here are official, but have been formulated for purposes of analysis. Each proposed set of force structures has been formulated to examine a broad range of reductions in strategic nuclear weapons. Specifically, the upper limit on the number of strategic nuclear warheads for each side has been varied to include consideration of three bounding limitations, 2500, 1500, and 800 warheads. The present goal of the United States and Russia appears to be a reduction to at least 2500 warheads on each side.

In this report, the strategic stability between the U.S. and Russia under the suggested frameworks for START III and other reductions is measured by the index of first strike stability and one indicator of geopolitical stability. First strike stability appears more restrictive than evaluations of central deterrence, and is believed to be more appropriate for examining future arms control agreements involving strategic nuclear weapons. The mathematics of first strike stability were introduced by several researchers of the Rand Corporation [3,4], and have been used by analysts within the U.S. and Russia [5,6,7] for evaluating the effects of different force structures and the effects of national missile defenses. In this report, we address each suggested limitation on nuclear warheads as well as considering the effects of both sides deploying ballistic missile defenses to protect facilities containing the valued assets of both sides.

Two chapters of this report indicate an outline of the method of analysis and the assumptions needed to implement the analyses of first strike stability. Later sections provide estimates of first strike stability under each assumed upper bound on nuclear warheads. The effects of varying levels of national ballistic missile defenses are also examined.

Geopolitical stability between Russia and the United States is important, but difficult to quantify. We define geopolitical stability as the state of international relations and understandings between nations. When neither side seems to present any threat to the other, trade relationships seem favorable to each, and diplomatic differences are minor and resolvable, then geopolitical stability is high. Currently, the geopolitical stability between the U.S. and Russia seems to be tending toward the high side. In this report, two factors which reduce the strategic threat are examined -- the fraction of strategic nuclear weapons that both sides are willing to place on a non-alert status, and the further reduction of strategic nuclear forces. Each of these factors are an indication of mutual political confidence. In a later chapter, we shall examine the interaction between these factors and first strike stability.

The final section of this report contains observations and conclusions concerning the broad range of force reductions that potentially could be considered for future agreements. Important aspects of our conclusions are related to the degree of potential reductions in strategic nuclear weapons, the extent to which strategic nuclear weapons may be placed on non-alert status, and the impact of both of these factors on first strike stability. References follow this final section.

OVERVIEW OF ANALYSIS METHODS

In this chapter, models of ballistic missile defense effectiveness and an attack planning system are briefly described. In the first model, the effectiveness of ABM is based on the assumption that defenses are random and subtractive. The second model provides planning information for an attacker based on assumptions about force structure and posture of a defender. In a later chapter, the assumptions concerning force structures and postures are given.

ABM Defenses

The first model is used to describe future anti-ballistic missile defenses. Little is known about future ABM defenses of the U.S. or Russia. Representation of ABM defenses is based on the assumption that such defenses will be random and subtractive. The kernel of the model is based on a uniform allocation of defensive interceptors against re-entering objects (RVs and decoys). The survival or penetration probability of the re-entry vehicles is given by

$$1) \quad P(pen) = \{1 - fp[I/(RV+D)]\} \cdot L^{INT[I/(RV+D)]} + fp[I/(RV+D)] \cdot L^{INT[I/(RV+D)+1]}$$

where P(pen) is the probability of penetration of the re-entry vehicles (RV), D is the number of decoys, I is the number of interceptors, and L is the leakage fraction of the interceptors, on average. A special function, fp(x), indicates the fractional part of x. The function INT(x) indicates the integer part of x. Figure 1 illustrates the probability of RV penetration as a function of the ratio of re-entry objects to the number of interceptors for a variety of leakage fractions. When the re-entry objects outnumber the defensive interceptors, then the probability of penetration given in equation 1 degenerates into a less complicated form.
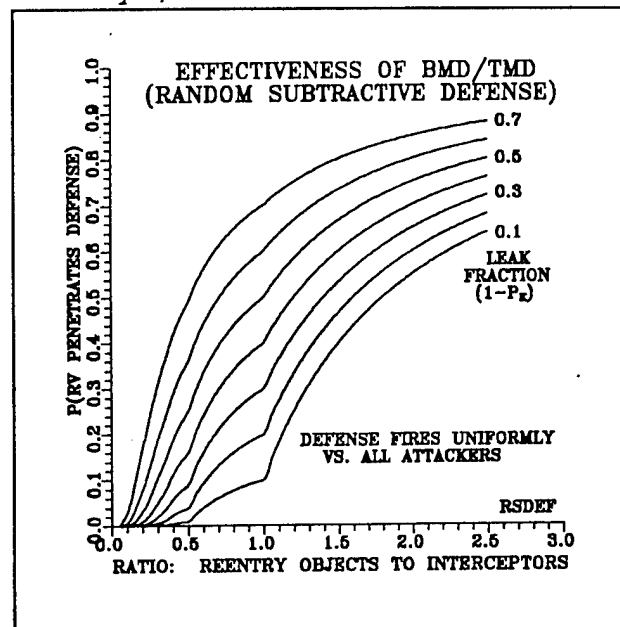

Figure 1

1a) P(pen) = 1 - I·(1-L)/(RV+D) when I < RV+D.

Attack Allocation and Planning

The essence of an attack allocation and planning model is presented in two parts. The first part is an allocation routine assigning attack weapons to defender bases in a manner to reduce the overall worth of the defender's strategic forces as efficiently as possible. Each attack warhead is assigned to a target which maximizes the damage to the "worth" of the defender's forces. In this analysis, the worth of a defender's force is measured in terms of the number of warheads. Within the force structures of the U.S. and Russia under the START II Treaty [8], the most lucrative target sets appear to be bomber bases, strategic submarine docks, and garrisons for mobile ICBMs. In these targets, there is a large concentration of warheads in each of an attacker's aiming points. In the model, the user may independently specify other measures of worth if desired.

The second part of the planning model assesses the number of defender warheads surviving the attack and assigns them to retaliate against the attacker's "value" targets. These targets are assumed to consist of other military targets that could be used for force projection, defense industries, and leadership facilities. Both sides may have ballistic missile defenses and defenses against bombers. ABM capabilities are represented by a random subtractive defense doctrine, and bomber defenses are represented by a single parameter, the probability of bomber penetration. ABM defenses are not assumed to be employed to protect strategic forces since each element of these forces has some means of passive defense such as hardening of silos, undetectable cruising under the sea for submarines, and strip alert for bombers.

Figure 2

Valued assets of the defender may or may not be defended against ballistic missile attacks. Value targets are assumed to follow an exponential distribution. The cumulative value at risk is given by
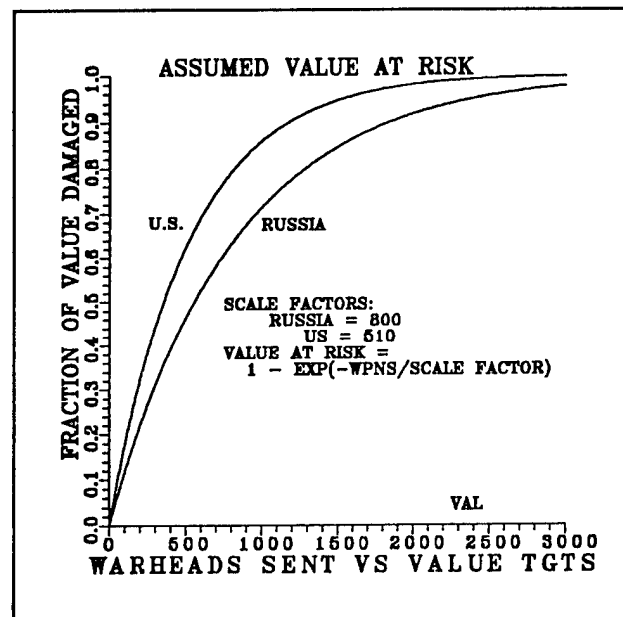
$$2) \quad VAL = 1 - e^{-W/SF}$$

4

where W is the number of attack warheads and SF is a so-called scale factor. Assumed scale factors for Russia and the U.S. are 800 and 510, respectively. These scale factors imply about 2500 and 1600 value targets for Russia and the U.S. respectively. If a single warhead were to arrive at all of these value targets, then the fraction of targets damaged would be approximately 0.96 for either side, as illustrated in Figure 2.

First strike stability is estimated by using the STRIK1ST program twice. Each side, Russia and the U.S., is assumed to strike first. In each application, the number of warheads aimed at strategic forces is found by minimizing the attacker's cost. The costs are those suggested by Kent and Thaler [3]. The costs to each side are the sum of the damage suffered plus a weighted factor which accounts for the damage not inflicted against the other contender.

3) $\quad \text{Cost(US)} = D(US)^{0.75} + 0.3 \cdot [1-D(RUS)^{0.75}]$

4) $\quad \text{Cost(RUS)} = D(RUS)^{0.75} + 0.3 \cdot [1-D(US)^{0.75}]$

In these formulae, D(US) and D(RUS) represent the damage done to value targets in the U.S. and Russia, respectively. The weighting factor assumed here is 0.3, as suggested by Kent and Thaler. The upper bound on cost under these definitions is 1.3.

First strike stability is defined as

5) $\quad \text{FSS} = \dfrac{\text{Cost(Russia First)} \cdot \text{Cost(US First)}}{\text{Cost(Russia 2nd)} \cdot \text{Cost(US 2nd)}}$

Each application of the attack planning model yields the costs needed for an estimate of first strike stability (FSS). When Russia is assumed to strike first, then the analyst picks out the minimum cost to Russia as the number of attacking warheads is varied. A similar procedure is followed when it is assumed that the U.S. strikes first. Final values of first strike stability are made by following the procedure outlined in equations 3, 4, and 5. The number of warheads needed to minimize the cost to an attacker are aimed at strategic force targets to reduce retaliatory damage. The remaining warheads in the first striker's attack would be directed to the defender's valued assets. Under these procedures, the attacker minimizes a function which includes <u>retaliatory damage</u> to the attacker, and <u>damage not inflicted</u> on the defender.

ASSUMPTIONS

Many assumptions must be made in assessing first strike stability and damage to each side's valued assets. The assumptions fall into several categories: the force structures of each side, the postures of various elements of these forces (alert rates for bombers and mobile ICBMs, at-sea rates for sea launched ballistic missiles), and the numbers and types of warheads that are available for first strike on each side. Four different force structures will be considered here. The assumed force structures under the START II Treaty will provide a basis for comparison to three reduced force structures. The three assumed force structures examined in this report will correspond to upper limits on strategic nuclear weapons of 2500, 1500, and 800 warheads. The forces under the limit of 2500 warheads is similar to that agreed to at the Helsinki Summit and also suggested by Mendelsohn [8]. The further reductions to 1500 and 800 warheads are approximately 1/2 and 1/4 of the limits suggested by the Russians under START II.

The postures of forces are defined as the fractions of force elements available for retaliation. Submarines at sea with sea launched ballistic missiles (SLBMs), bombers on strip alert, and mobile ICBMs deployed away from their garrisons are assumed to be invulnerable to a first strike and could be used in a retaliatory strike. Posture A represents the conditions that seem to exist at the present time -- no bombers on strip alert, and no Russian ICBMs deployed away from their garrisons. Both the U.S. and Russia are assumed to have SLBMs at sea, although the at-sea rate for Russian submarines is assumed to be about one-half that of the U.S. Posture B indicates conditions as they might have been during the cold war, and might exist given strategic warning leading to higher rates of alert.

The force structures and postures assumed in this report are displayed in Tables 1 and 2. The baseline case, START II, has been formulated for analysis purposes relying on two references. The first is a review conducted by within the U.S. Department of Defense [10], and the second is a suggestion by a researcher at the Institute for the USA and Canada Studies in Moscow [11]. The postures in Table 2 are those assumed by the author. In all cases where reductions are considered, the force structures contain all three elements of a triad of offensive strategic nuclear weapon systems (ICBMs, SLBMs, and bombers).

Table 1 - POTENTIAL FUTURE FORCE STRUCTURES

Weapon Type	START II Bases	Whds	Limit=2500 Bases	Whds	Limit=1500 Bases	Whds	Limit=800 Bases	Whds
U.S.								
Minuteman	500	500	448	448	500	500	96	96
Trident	14	1344	12	1152	5	480	4	384
B-52	11	1320	10	580	2	192		
B-2	2	320	2	320	2	320	4	320
TOTALS		3484		2500		1492		800
Russia								
RS-18(silo)	105	105	105	105	105	105		
RS-12(mobile)	40	360	40	360	40	360	40	360
RS-12(silo)	350	350	130	130				
Typhoon	6	720	6	960	4	640		
Delfin	7	448	7	448			5	320
Kalmar	11	528						
TU-95 (Bear)	10	600	10	368	3	272		
TU-160 (B-Jack)	2	120	2	120	2	120	2	120
TOTALS		3231		2491		1497		800

Table 2 - POTENTIAL FUTURE FORCE POSTURES
(Fraction on alert, away from garrison, or at sea)

Weapon Type Postures	START II A	B	Limit=2500 A	B	Limit=1500 A	B	Limit=800 A	B
U.S.								
Minuteman	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Trident	0.64	0.64	0.67	0.67	0.6	0.6	0.75	0.75
B-52	0.0	0.33	0.0	0.34	0.0	0.31		
B-2	0.0	0.3	0.0	0.4	0.0	0.4	0.0	0.4
Russia								
RS-18(silo)	1.0	1.0	1.0	1.0	1.0	1.0		
RS-12(mobile)	0.0	0.5	0.0	0.5	0.2	0.5	0.4	0.8
RS-12(silo)	1.0	1.0	1.0	1.0				
Typhoon	0.33	0.33	0.33	0.33	0.5	0.5		
Delfin	0.29	0.29	0.29	0.29			0.4	0.4
Kalmar	0.27	0.27						
TU-95	0.0	0.3	0.0	0.3	0.0	0.29		
TU-160	0.0	0.3	0.0	0.3	0.0	0.3	0.0	0.4

In addition to the force structure and alert postures outlined in Tables 1 and 2, the assumed postures of forces for first strike for both sides are given in Table 3. Again, these assumptions are those of the author.

Table 3 - ASSUMED FIRST STRIKE FORCES
(FULLY GENERATED)

Weapon Type	START II	Limit=2500	Limit=1500	Limit=800
U.S.				
RVs	1652	1408	884	384
Bombers	1120	640	372	256
Russia				
RVs	1930	1483	873	544
Bombers	360	324	304	96

Further, probabilities for damage against each type of target have been assumed for this analysis. These levels of damage include the availability and reliability of weapons selected for attack and are: 0.6, 0.7, 0.8, 0.8 for single weapons attacking silos, submarine docks, airfields, and ICBM garrisons, respectively.

FIRST STRIKE STABILITY AND ABM

This section provides evaluations of first strike stability under a potential warhead reductions meeting three different limits on strategic nuclear weapons: 2500, 1500, and 800 warheads. In addition, the effect of deploying up to 1000 anti-ballistic (ABM) interceptors will be considered.

First strike stability will vary as a function of the postures assumed for each of the opposing strategic nuclear forces. Posture A represents the conditions since Presidents Bush and Yeltsin agreed to remove all bombers from strip alert. Posture B represents a condition where bombers would be put back on strip alert and a fraction of the mobile ICBMs in Russia would be deployed away from their garrisons. These forces are assumed to be invulnerable to a first strike.

Figures 3, 4, and 5 show the first strike stability as a function of the number of ABM interceptors deployed for each of the warhead limits assumed.
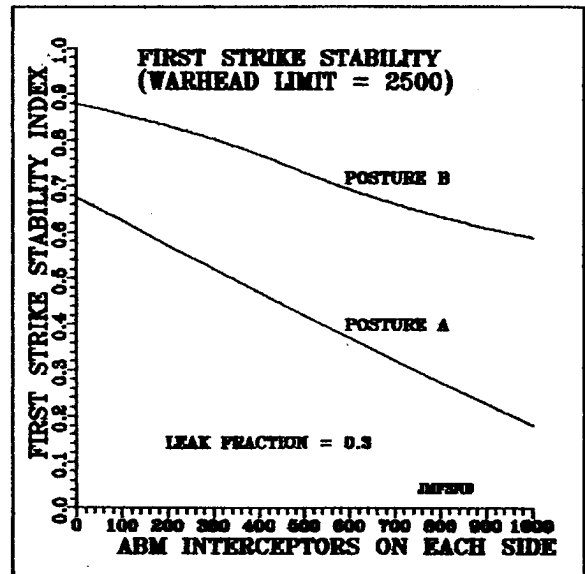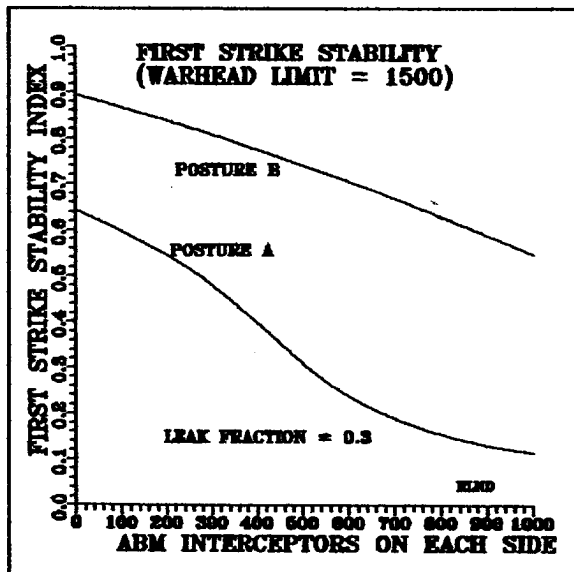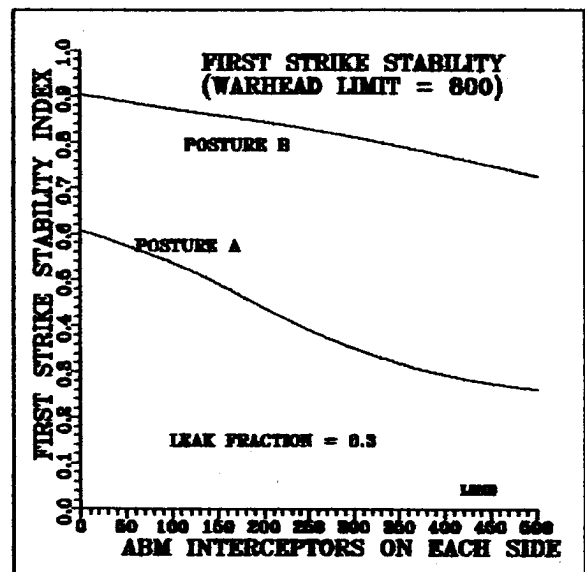

Figure 3

Figure 4

Figure 5

9

Without ABM, the first strike stability decreases somewhat as the limit on warheads is lowered, even though slight increases in alert rates were assumed as the limit on warheads was decreased. The decreases in first strike stability are modest for Posture A (0.68 down to about 0.61). In Posture B, first strike stability without ABM is nearly the same for all three limits considered, about 0.88 to 0.90. In all three cases, first strike stability decreases considerably in Posture A as ABM interceptors are deployed. If the number of interceptors is limited to 100 or less, as under the numerical limits of the ABM Treaty, then first strike stability decreases are quite modest.

If there is an interest in maintaining first strike stability above some arbitrary level, then the number of interceptors that can be deployed to prevent first strike stability from falling below this level decreases with decreases on warhead limits. For example, if it were desired to maintain a first strike stability of 0.5 or more, the maximum number of ABM interceptors (with a leak factor of 0.7), would be 340, 280, and 140 for warhead limits of 2500, 1500, and 800, respectively.

The higher alert rates of Posture B result in higher first strike stability values than is the case for Posture A. Whether or not forces could be placed on the higher alert rates needed to meet Posture B goals may be in question in a rapidly developing crisis. Increased alert rates for the strategic nuclear forces might cause political tensions to rise dramatically even though the higher alert rates would improve first strike stability. To decrease the incentives for either side to strike first, both sides would need to recognize that alert rates had been increased, thus emphasizing the role of intelligence in a crisis situation. Overestimation of the number of warheads on an alert status might lead to a perception that one or the other side might be preparing for a first strike when such might not be the case.

Overall, first strike stability under Posture A decreases markedly as ABM capabilities are increased. If forces are placed in higher states of alert (Posture B), then first strike stability is higher than under the assumed present conditions, and increases in ABM capabilities result in a lesser decrease in first strike stability.

EFFECTS OF COUNTERMEASURES TO ABM
AND FIRST STRIKE STABILITY

What would happen if both the U.S. and Russia were to devise countermeasures that would spoil the effectiveness of ABM defenses? To examine this question, it has been assumed that Russia and the United States could deploy perfect decoys to lessen the effectiveness of either sides' ABM systems. The ratio of decoys to RVs is assumed to be two to illustrate the effects of one method of countering an ABM system. The first striker and the retaliator would allocate one RV against each value target, and then allocate decoys to accompany each RV based on the value of the particular target. Under this doctrine, the value saved by an ABM system would be equal per interceptor committed no matter which RV and its decoys were brought under defensive fire. The random subtractive defense model used in this analysis captures the essence of this decoy allocation scheme. First, the matter of first strike stability is addressed. Subsequently, the credibility of decoys is analyzed.

First Strike Stability: RVs and Decoys versus ABM

The results of both sides employing decoys to decrease the effectiveness of ABM defenses is shown in Figures 6, 7, and 8. First strike stability is shown as a function of the number of ABM interceptors deployed by each side for Postures A and B with and without decoys accompanying RVs. The employment of decoys degrades defense effectiveness and causes a much lower decrease in first strike stability as defenses are increased compared to cases where decoys are not employed by either side. Under these circumstances, degradations in first strike stability might be tolerable even if both sides were to deploy very large ABM systems. However, one could argue that if large ABM systems are so easily countered, then it would be foolish to deploy them in the first place. Such an argument has great merit when confrontations between superpowers and large nuclear exchanges are involved. For lesser confrontations with rogue nations, each of the superpowers may decide that they need limited ABM defenses to counter limited attacks or accidental launches of ballistic missiles.
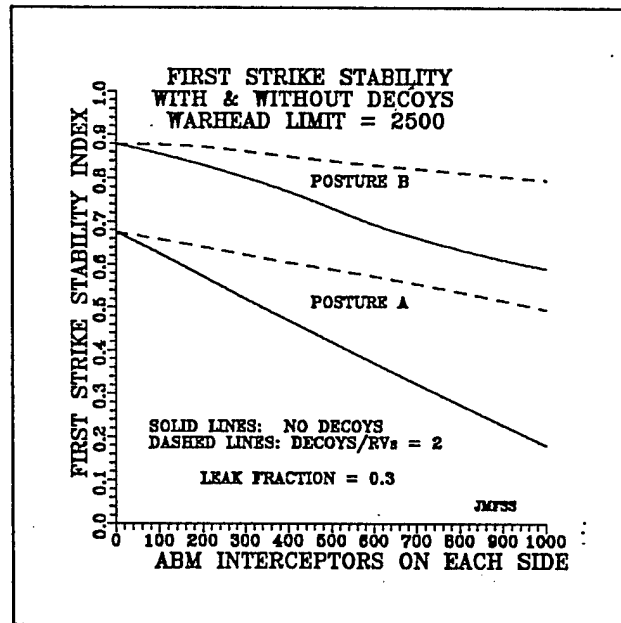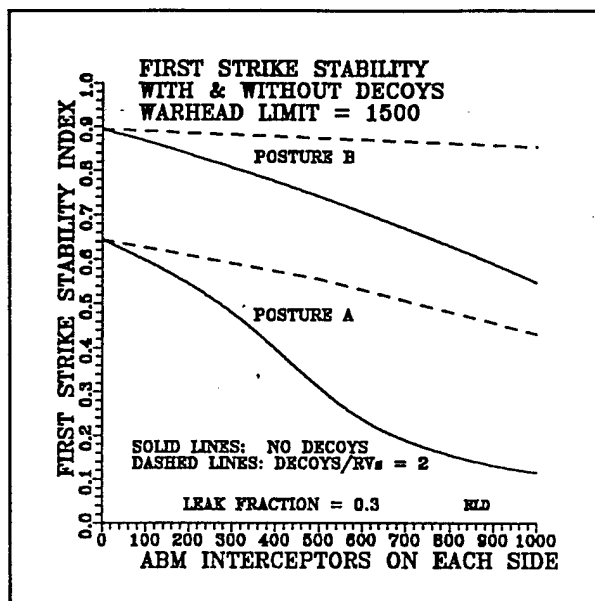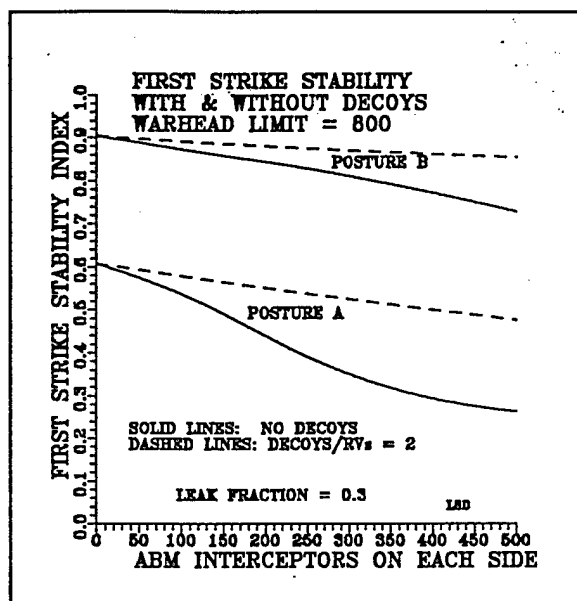

Figure 6

11

Figure 7

Figure 8

Decoy Credibility

One critical issue is that of the credibility of the decoys accompanying the attacking or retaliating re-entry vehicles. First, we present the outline of an analysis that examines credibility, and then address the question of the number of less than perfect decoys that would be needed to achieve the same results as the use of perfect decoys.

When examining less than perfect decoys or partial discrimination capabilities, the important parameters are the number of perceived RVs and decoys. The perceived number of RVs is given by

6) $PRV = (1-f) \cdot RV + g \cdot D$

and the number of perceived decoys is given by

7) $PDC = (1-g) \cdot D + f \cdot RV$

where RV is the actual number of RVs, and D is the actual number of decoys. The probability that an RV is perceived as a decoy is f, and the probability that a decoy is perceived as an RV is g. So long as f+g<1, then the number of interceptors committed against the perceived RVs which minimizes the probability of penetration of the RVs is given by

12

8) INTRV = PP1·PP2 if f+g<=1 or
          = PP1 if f+g>1

where PP1 is a uniform allocation of interceptors

9)   PP1 = I·PRV/(PRV + PDC)

and PP2 is unity plus a hedge factor based on known misperceptions and interceptor effectiveness.

10)   PP2 = 1 + PDC/I·$\log_e$[PRV/PDC·f/(1-f)]/$\log_e$(L)

The leakage rate, on average, is represented by L. This methodology was developed during the course of the ABM debate in the late sixties [12].

Finally, the index of decoy credibility is defined as the sum of the two misperception probabilities,

11)   IC = f+g.

This index in the range of interest varies between zero and one. When IC = 1, then the decoys are perfectly credible, i.e., the defender has no capability to discriminate between RVs and decoys and shoots all interceptors uniformly at all re-entry objects. When IC=0, then the defender has a perfect capability to discriminate between RVs and decoys, and the decoys are not credible. If f+g>1 and the defender is not aware of this condition, then interceptors will be preferentially aimed at decoys as though they were the RVs.

As the index of decoy credibility is lowered, then the probability that attacking RVs penetrate an ABM is also lowered. Under such degradations, the attacker has the option of sending more decoys, if he can assess the index of decoy credibility or the discrimination capability of the defending ABM system, assuming that the defender has properly assessed his own discrimination capabilities through flight testing against decoys used by the attacker.

Figure 9 shows the ratio of imperfect decoys to RVs that the attacker must employ to preserve the same effectiveness provided by a ratio of perfect decoys to RVs equal to two as a function of the index of credibility for leakage rates of 0.7 or less. The number of decoys increases rapidly as the index of decoy credibility is decreased and may raise questions concerning payload limitations of U.S. and Russian ballistic missiles. On the U.S. side, reductions agreed to under START II would provide a throw weight surplus for both the Minuteman ICBM and the Trident SLBM. The same argument may apply to Russian SLBMs, but excess throw weight on the RS-12 ICBM could be limited unless lighter weight warheads are developed in the future. Most

students of ballistic missile
defense systems would probably
agree that discrimination
would not be perfect. Some
analysts might maintain that
discrimination would be far
from perfect and decoys might
be mistaken for RVs in most
engagements. The author tends
to side with the latter group
of observers since the exact
nature of decoys used by
either side may be difficult
to determine ahead of any
crisis if any of the opponents
are able to conduct tests
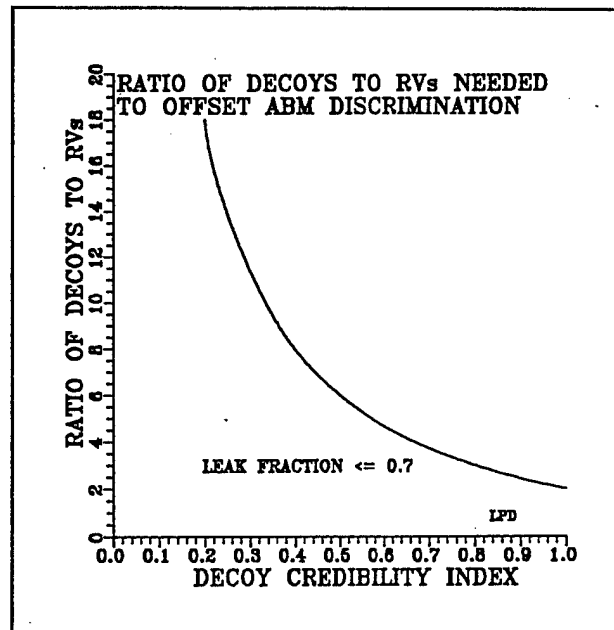without open observation of
testing procedures.

Figure 9

FIRST STRIKE AND GEOPOLITICAL STABILITY

The purpose of this section is to show the potential interaction between first strike stability and one indicator of geopolitical stability. First strike stability was defined earlier.

Geopolitical stability seems to be a non-quantifiable measure of the political relations between two nations, in this case, between the U.S. and Russia. At the very least, the ingredients of geopolitical stability would include 1) the state of relations and understandings on central issues of the two states, 2) the degree of amicability concerning commerce and trade, 3) the extent of diplomatic differences concerning non-central issues, and 4) the extent of threatening intentions or capabilities. Examples of these ingredients might include support of the ABM and other treaties, expansion of NATO, START I, START II (central issues), the extent to which American and Russian companies are forming industrial partnerships (commerce and trade), and potential agreement or contention about third world activities such as nuclear power in North Korea, or the state of affairs in the Middle East (non-central issues). With regard to the extent of threatening intentions or capabilities, one indicator selected for this analysis is the degree of relaxation of military tensions, namely, the non-alert status of strategic nuclear forces on each side.

How far are the U.S. and Russia willing to go in placing their strategic forces on a non-alert status? There are two practical approaches to the answer to this question. First, one might examine the effects of taking bombers and mobile ICBMs off of alert, followed by keeping strategic missile carrying submarines in port. While either side may state that their ICBM force is not on alert, this status is not easily verified, or may be rapidly reversed with few outside indicators. In this case, the analyst must assume that ICBMs are always on alert or may be rapidly be brought to this state of readiness. This approach may be easy to implement by both sides, as already has been observed by an agreement to remove bombers from strip alert. Under this approach, the following tables might serve to show the first strike stability as a function of decreasing alert status for the strategic forces of both sides. Table 4 outlines the assumptions concerning alert rates for various elements of the strategic forces. Table 5 enumerates the effects on first strike stability for the reductions examined in this report.

Table 4 - POTENTIAL POSTURES FOR DECREASING ALERT RATES

Posture   Description of each Posture

1. Russia: Mobile ICBMs away from garrisons = 50%
             Submarines at sea = 30%
             Bombers on strip alert = 30%
      U.S.: Submarines at sea = 67%
             Bombers on strip alert = 30%

2. Russia: Mobile ICBMs away from garrisons = 0%
             Submarines at sea = 30%
             Bombers on strip alert = 0%
      U.S.: Submarines at sea = 67%
             Bombers on strip alert = 0%

3. Russia: Mobile ICBMs away from garrisons = 0%
             Submarines at sea = 0%
             Bombers on strip alert = 0%
      U.S.: Submarines at sea = 0%
             Bombers on strip alert = 0%

Each posture represents an ever decreasing alert rate for the strategic forces on each side. Numerical values may vary somewhat from those given above, but the general trend is downward with regard to alert or at-sea rates. Table b indicates the effect on first strike stability.

Table 5 - FIRST STRIKE STABILITY AND ALERT RATES

POSTURE	START II	LIMIT = 2500	LIMIT = 1500	LIMIT = 800
1.	0.93	0.88	0.90	0.90
2.	0.68	0.68	0.65	0.61
3.	0.04	0.04	0.04	0.04

Wholesale cuts in the alert or at-sea rate yield dramatic effects on first strike stability. Such cuts may be overall options desired to implement for political reasons, but as illustrated in the above table, keeping all submarines in port for all of the warhead limits considered results in a reduction of first strike stability that may not be agreeable to both sides. The low numbers associated with Posture 3 are based on the assumption that all ICBMs would be on alert, but would not launch on warning of attack, nor would be launched while under attack. The non-alert forces provide a very limited number of vulnerable targets with high worth, and the ICBMs in silos are limited in number (compared to Cold War counting), so that a large fraction of attack warheads could be devoted to damaging value targets, no matter who is assumed to strike first.

A second approach to examining reductions in alert rates for strategic forces is more gradual in nature. In this approach, the alert rate of each element of the strategic forces on both sides is reduced so as to preserve the role of each element of the triads, ICBMs, SLBMs, and bombers. As the non-alert rate increases for each of the suggested warhead limits, each element of the strategic forces are reduced in proportion to the total warhead limit. With this approach, portions of the submarine fleet and bomber force are removed from at-sea or strip alert postures as the overall fraction on alert is decreased. For the Russian side, the same proportional reductions apply, but also are appropriate for their mobile ICBMs.

The results of this more gradual approach to increasing the non-alert rate of strategic forces is shown in Figure 10. In this figure, the first strike stability is shown as a function of the fraction of forces with a variable alert rate on non-alert status. Since it would seem difficult to an outside observer to discriminate betweeen ICBMs that are on alert and those that are not, these results include the assumption that all ICBMs in silos are always on alert. These results also include an assumption that the alert rate or at sea rates for bombers, mobile ICBMs, and submarines are set initially at 100%, and then decreased proportionally as the non-alert rate is increased. At the end point, a non-alert rate of 0%, only the ICBMs in silos are assumed to be on alert.
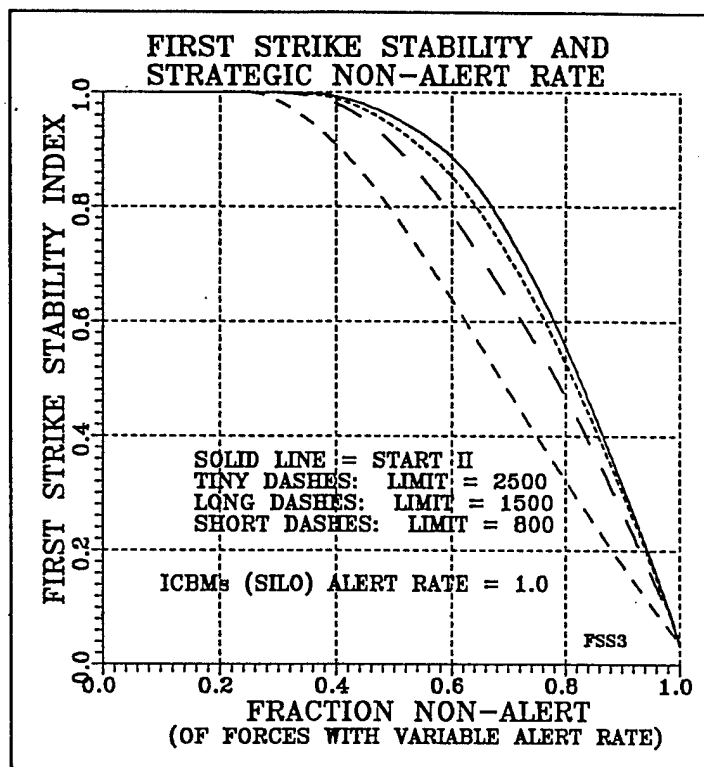

Figure 10

Figure 10 shows that when the non-alert rate is low, the first strike stability is extremely high, but does degrade as the non-alert rate is increased for all of the warhead limits considered here. At lowered warhead limits, the first strike stability is lower at non-alert rates of 0.4 to 0.9 than those estimated to prevail under START II. The main point to be drawn from this figure is to show how far political amity may be pushed in terms of force-wide non-alert rates without upsetting first strike stability. Increases in non-alert for strategic forces

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may be a method of assuring geopolitical stability, but does provide some drawbacks in terms of first strike stability, and this tradeoff is illustrated here.

Figure 10 does not illustrate the effects of a reversal of of a need to increase alert rates, should the geopolitical stability be perceived as decreasing because of other non-quantitive trends such as deteriorating diplomatic or economic relations, or growing disagreements between Russia and the U.S. In the face of such deteriorations, either the U.S. or Russia may decide to lower non-alert rates of their strategic forces. Intelligence organizations may detect the increases in strategic alert rates, and their projections could be in error or misinterpreted. In an extreme case, detected increases in alert rates could be interpreted as one side or the other preparing for a first strike. While placing more forces on higher states of alert would improve first strike stability, such steps could serve to lessen geopolitical stability and could raise false alarms for either side. Diplomatic consultation between the two sides might aid in calming such situations, but such exchanges may not resolve uncertainties in perceptions and interpretations to the satisfaction of either or both participants. While placing more and more strategic nuclear forces on non-alert status may promote geopolitical stability, withdrawing them from non-alert status may involve internal political crises within the governments of the U.S. or Russia, or both.

OBSERVATIONS AND CONCLUSIONS

The purpose of this report has been to provide one perspective on successively deeper reductions in the number of strategic nuclear weapons possessed by the U.S. and Russia. This perspective has been based on two distinct quantitative measures. The first is a crucial aspect of crisis stability, first strike stability. The second is one indicator of peacetime geopolitical stability, the fraction of strategic nuclear weapons not on alert status.

The scope of these analyses has been limited. The number of strategic nuclear weapons possessed by the U.S. and Russia has been assumed to vary, but in a decreasing fashion to provide insights into deeper and deeper reductions in nuclear arsenals. The reduction options begin with the START II limits and then involve decreased upper limits on the number of strategic nuclear weapons on each side. The reduction considered here are outlined in Figure 11. This figure indicates the total warheads considered, and also indicates the assumed force mixes consisting of ICBMs, SLBMs, and bomber weapons.
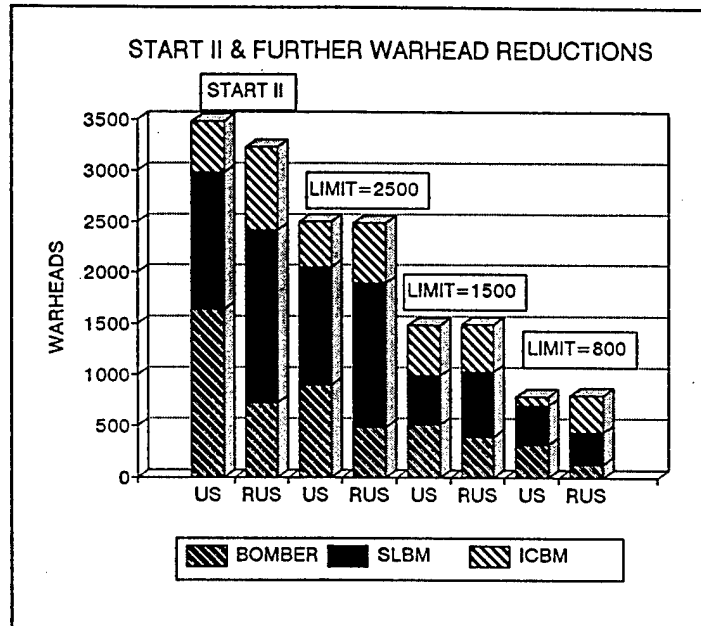

Figure 11

First strike stability is an indicator of the lack of incentive for either side to strike first. First strike stability will decrease, or incentives to strike first will rise, under the influence of two major parameter variations: the posture of forces, and the deployment of anti-ballistic missile defenses on both sides. As the force posture or alert status of forces is decreased, then first strike stability decreases. As more and more interceptors are added to increase the robustness of ABM defenses, first strike stability also decreases. At the extreme limits of interceptor deployment considered here, the first striker's ABM seriously degrades the damage inflicted by a retaliatory strike, thus increasing incentives to strike first. A major shift in this trend was observed when credible decoys were deployed by both sides on their ballistic missiles. The effect of decoys was to spoil the effectiveness of retaliatory strikes thus reducing the degradations in first strike stability

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caused by introducing ABM defenses. If decoys are not completely credible, then more would need to be deployed beyond a ratio of decoys to RVs of two. Small amounts of ABM defense, 100 interceptors or less, would result in minimal decreases in first strike stability. If the intent of both sides were to deter or counter limited strikes by ballistic missiles, then deployments of up to 100 interceptors by each side may be judged to be acceptable on both sides. Even though the ABM Treaty permits each side to deploy 100 interceptors, Article I bans the deployment of a national ballistic missile defense. Changes to the ABM Treaty would be needed to accomodate even limited deployments of national ballistic missile defenses.

The third major parameter in this analysis, the reductions in strategic nuclear arsenals, did not result in severe degradations in first strike stability. In part, first strike stability index degradations were minor because the alert rate of some of the forces were increased slightly as the number of strategic nuclear weapons on each side was reduced. Alert rates, or force postures, are important aspects of first strike stability, as well as in considerations of geopolitical stability.

Not all of the elements of geopolitical stability are quantifiable, but remain a matter of perception by leaders of the U.S. and Russia. At the least, the ingredients of geopolitical stability would seem to include:

1) the state of relations and understandings on central issues of the two countries,

2) the degree of amicability concerning commerce and trade,

3) the extent of diplomatic differences concerning non-central issues, and

4) the perception or extent of threatening intentions or capabilities.

The indicator of geopolitical stability selected in this analysis concerns perceptions concerning threat, or the degree of relaxation of military tensions, namely, the non-alert status of strategic nuclear forces on each side.

In past years, geopolitical stability has seemingly increased when both the U.S. and Russia agreed to remove strategic bombers from continuous strip alert. The agreement to do so was perceived as an act of good will and willingness to reduce military tension after the end of the Cold War. As noted in earlier sections of this report, such actions did decrease first strike stability, but were deemed acceptable in favor of promoting geopolitical stability and the display of intentions

toward establishing a more peaceful relationship. How far would both sides be willing to go in reducing alert rates? One result of the present analysis indicates the tradeoff between first strike stability and the fraction of forces on non-alert status. The results are repeated here to provide an overview of various important effects.

Figure 12 indicates the extent of possible conflict between first strike and geopolitical stability indices. In general, substantial fractions of nuclear forces can be removed from alert status while preserving a high degree of first strike stability. When all forces are placed on alert, a status that may be impossible to achieve, then first strike stability is at its upper limit -- the first striker has no incentive to go first since he would face a very damaging retaliation. In methodological jargon, the cost of going first for either side would be the same as waiting and going second.

Figure 12

Decreases in first strike stability begin to occur when about half of the nuclear forces on both sides are placed on a non-alert status. At this point first strike stability also begins to degrade as the limits on nuclear arsenals are decreased. For the condition where 80 per cent of forces are on non-alert status, first strike stability under START II limits may be considered acceptable, or marginally so. First strike stability under an arsenal limit of 800 warheads could be judged as being too low for comfort. Overall, higher fractions of nuclear forces can be placed on non-alert status when warhead limits are high than might be tolerated under conditions when the warhead limit is low, if the goal is to preserve some constant level of first strike stability. The reader is cautioned that this indicator, the fraction of forces on non-alert status, is but one aspect of geopolitical stability, and that the other elements must surely enter into considerations by political leaders on how far they might agree to procede in taking strategic nuclear forces off of their alert status at the same time making deep reductions in force size. The major point of
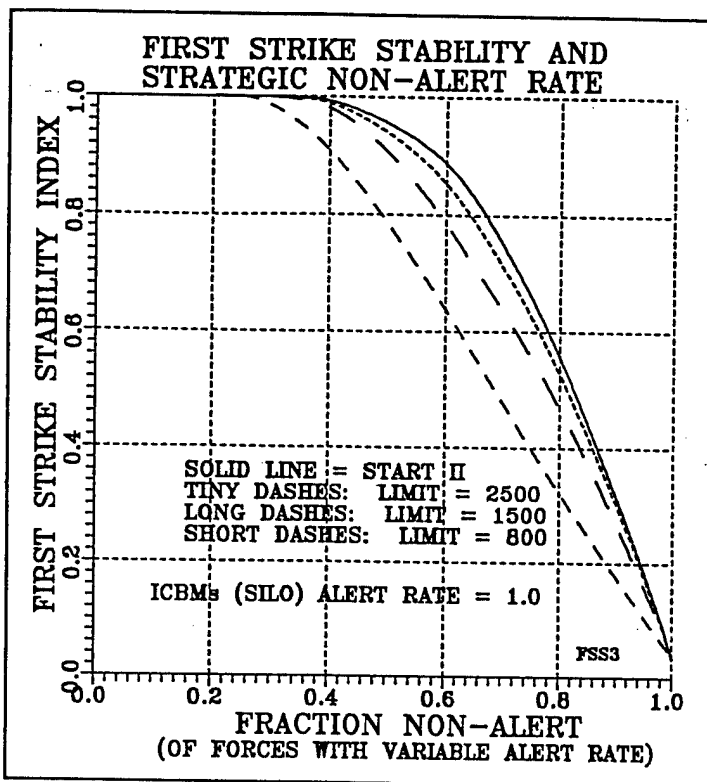
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our results is that as lower warhead limits are considered, some degradations in first strike stability can be offset somewhat by adjusting alert rates, should such modifications to force posture be deemed necessary.

The objectives in promoting geopolitical stability and in preserving first strike stability usually are not in accord. From this limited analysis, political objectives in providing peaceful relations may call for tolerance in terms of reduced first strike stability. On the other hand, efforts to restore first strike stability after initially taking nuclear forces off of alert status may be viewed as an alarming degradation of political factors if a crisis were to occur. A state of balance may not be enduring over time, and factors beyond the scope of this analysis may be more important.

From this analysis, it appears very likely that first strike stability and geopolitical stability can be preserved at tolerable levels even at reduced warhead levels beyond those in START II or agreed to under the recent accords reached in Helsinki [2]. However, this analysis does not account for the arsenals or the political goals of other nations such as China, North Korea, Britain, or France, to mention but a few other potential contenders. At very low levels of nuclear forces, any confrontational situation may become multi-polar in nature. If all nations eventually come to the view that nuclear weapons are unusable, then deep reductions in the nuclear arsenals of the U.S. and Russia may be possible.

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The purpose of this addendum is to provide an illustration which might answer yet one more question by readers. Figure 13 indicates one further comparison not shown in Figure 11 in the main body of this report.
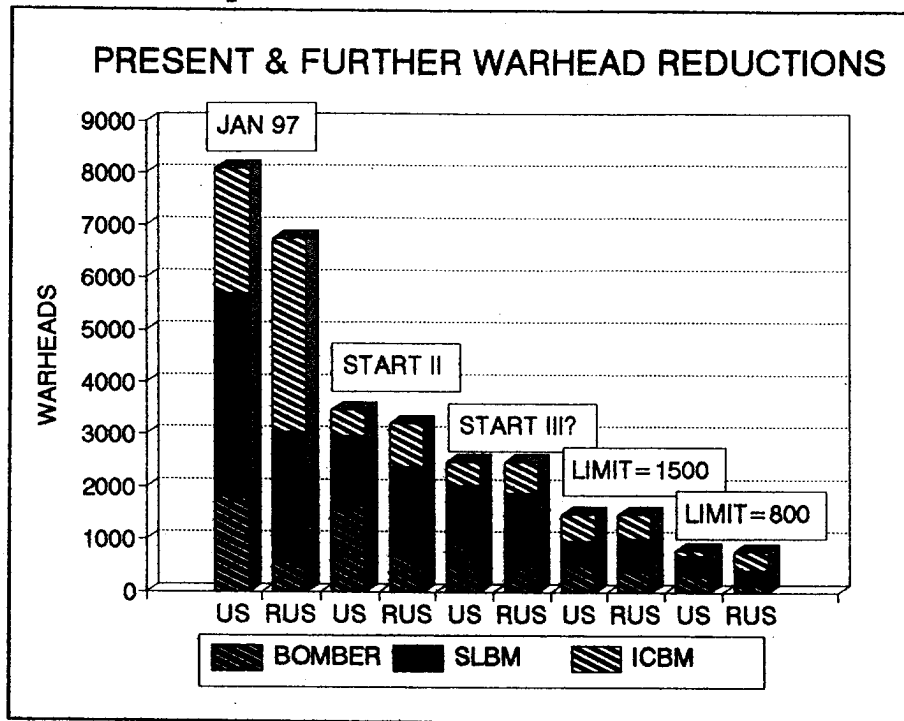
PRESENT & FURTHER WARHEAD REDUCTIONS

Figure 13

During briefings of this report, many listeners wanted to know the present status of strategic nuclear warheads in Russia and the United States. This figure provides estimates as of January, 1997. The data was drawn from the START I Memorandum of Understanding, January 1, 1997, appearing in Arms Control Today, March, 1997. From this data, substantial reductions in nuclear weapons still await achievement before both sides meet the terms of the START II Treaty. As of this writing, the U.S. Senate has ratified the treaty, but the Russian Duma has not. The future on this score appears uncertain at the present time.